Electronic control of the dispatch schedule as means of reduction of emissions of harmful substances by buses

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Introduction. Environmental contamination by vehicles is one of the main and important questions. Road transport is on the first place by quantity of harmful substances released into the atmosphere. The railway transportation pollutes environment by 3 %, planes — by 6 % from the total amount of pollution. The rest is motor transport. As it is known, the maximum quantity of harmful substances is thrown out in an idle mode of work of the engine, i.e. at idle times at stops. The improvement of an ecological situation on transport highways is possible by the optimization of movement of city public transport.

Problem Statement. The task was to develop a project that allows you to eliminate violations of the dispatch schedule of city buses. It is proposed to use the computer program "Line Dispatcher" developed by the authors and a mobile application to monitor the compliance with the dispatch schedule.

Theoretical Part. The field observations carried out on one of the most intense sections of the transport arteries of Rostov-on-Don — the ring at the intersection of Vavilova and Koroleva streets — show how many buses produce harmful emissions only on one section, stand idle at the stop, do not fulfill the dispatching schedule, and, thereby, worsen the environmental situation in the city. The authors have developed a computer program "Line Dispatcher", which allows you to: download a map of the city or a district, the information about the stops on the route and the timetable; choose the desired route; monitor the movement of the bus according to the schedule. The mobile app can be installed on any smartphone of the driver and dispatcher.

Conclusion. A practical solution is proposed to optimize the activity of public transport, which will eliminate downtime at stops due to electronic control of the dispatch schedule and reduce emissions of harmful substances by urban public transport.

Keywords: ecology, transport, polluting emissions, software product, mobile application.

Introduction. In modern society, the quality and reliability of vehicles is significantly increasing. At the same time, the intensity of traffic on the streets of large cities increases dramatically. Various solid, liquid and gaseous wastes in the form of sulfur, nitrogen, lead compounds, as well as soot and various hydrocarbons enter the atmosphere, water bodies, underground water and soil. The environmental situation is deteriorating as a result of the work of various transport complexes.

There are 110 city bus routes in Rostov-on-Don, and more than five hundred within the Greater Rostov agglomeration. In addition, more than 250 flights depart from Rostov to different cities. Despite the measures taken to protect the environment, the amount of emissions of pollutants into the atmosphere from motor vehicles increases by an average of 4.1% per year. As a result, in the Russian Federation, a huge amount of carcinogenic substances from motor vehicles enters the atmosphere every year: 29 thousand tons of benzene, 19.5 thousand tons of formaldehyde, 1.9 tons

of benzpyrene and 7 thousand tons of lead. In general, the total amount of harmful substances emitted by cars annually exceeds the figure of 27 million tons [1-4].

Problem Statement. The field observations conducted on one of the busy sections of the transport arteries of Rostov-on-Don (the ring at the intersection of Vavilova and Koroleva streets) show that harmful emissions are produced by a large number of vehicles.

Field observations were carried out on various bus routes in order to record the real time of bus standing at bus stops. If the average standing time is 0.47 minutes, then at busy intersections, many buses are idle from 3.48 to 4.11 minutes or more. Drivers break the schedule, trying to land as many people in the bus as possible.

It is necessary, using modern digital technologies, to develop a project that allows you to eliminate violations of the schedule of city buses. To monitor the compliance with the dispatch schedule, it is proposed to use the Line Dispatcher computer program developed by the authors and a mobile application for this program.

Theoretical Part. On the section of the ring at the intersection of Vavilova and Koroleva streets, the field observations were carried out, which allowed us to analyze the transport situation, shown in Figures 1-2.

The observations were made on Monday, Wednesday and Friday in the morning from 7.30 am to 9.00 am and in the evening from 17.00 pm to 19.00 pm. Figure 1 shows the number of cars, trucks, and cyclists on the days and hours indicated above. Figure 2 shows the number of buses in the morning and evening hours.
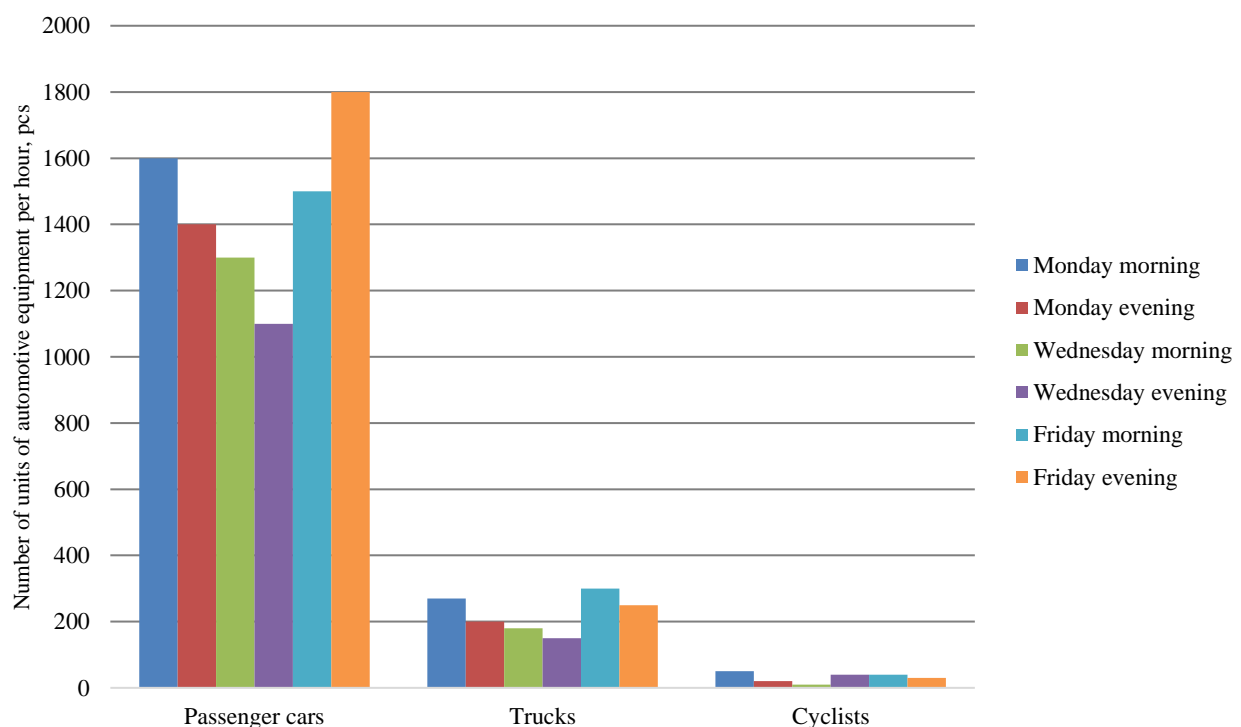

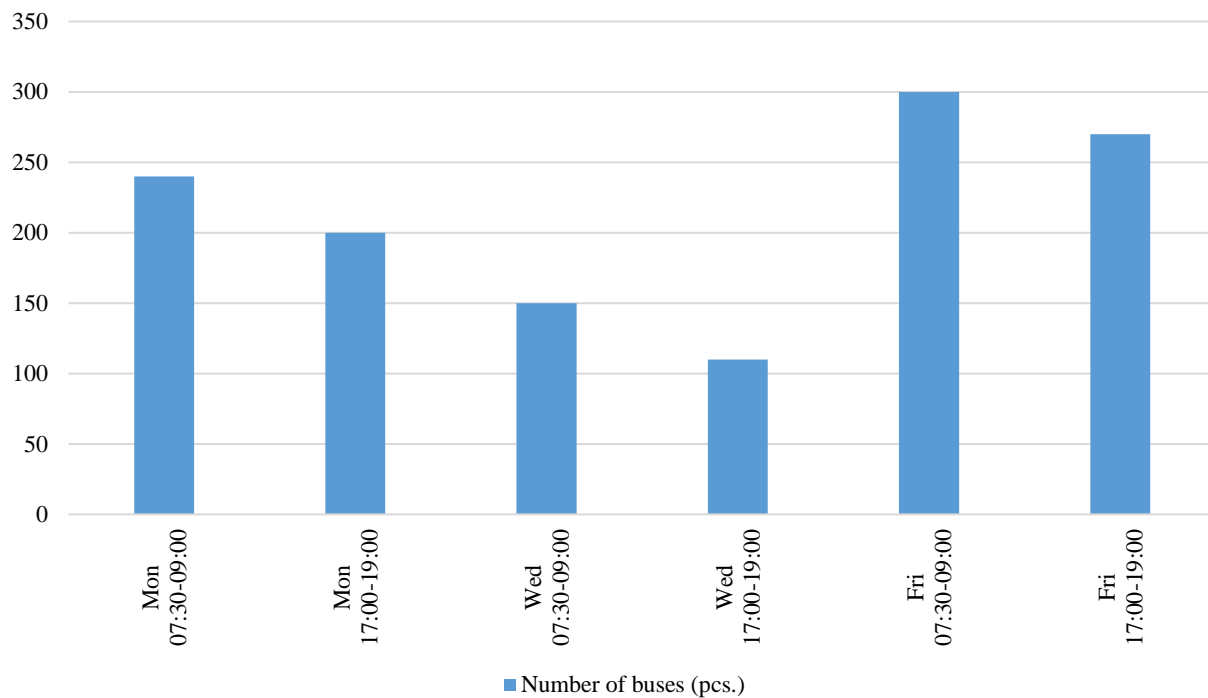Fig. 1. Number of cars at the intersection of Vavilova and Koroleva streets

Fig. 2. Number of buses on the ring at the intersection of Vavilova and Koroleva streets in different time

The improvement of the environmental situation on transport highways is possible by optimizing the movement of urban public transport [5-12]. On the road, there are line dispatchers who should regulate traffic. According to the director of the Department of Transport of Rostov-on-Don, it is not yet possible to completely abandon the work of line dispatchers and switch to an electronic system for monitoring the traffic schedule. The only company that has managed to do this is the ATP-3. Buses of this company, following routes No. 96 and No. 94, run well-managed and without downtime.

In this paper, we propose a Line Dispatcher software package and a mobile application that can be installed on the phone of the driver and the dispatcher. This will allow the dispatcher to track the fulfillment of a schedule, eliminate long downtime at stops in the pursuit of profit.

Line Dispatcher software product. Taking into account the current situation with the movement of public transport in the city, a computer program in C++ is proposed that allows you to control the accuracy of the schedule on the route and replace line dispatchers.

The program allows you to:

— upload a map of the selected city or area;

— choose the desired route;

— read the information about the stops on this route from the database;

— download the schedule for this route;

— monitor the movement of the bus within the time frame of the schedule;

— inform the driver using the warning light (red or green) that it is still possible to stand at the stop or it is time to leave;

— send the information to the dispatcher.

Figure 3 shows the start menu of the program. You should select the bus route number from the vertical menu. After selecting the bus route number, a list of all stops of the selected route number is available (Fig. 4).
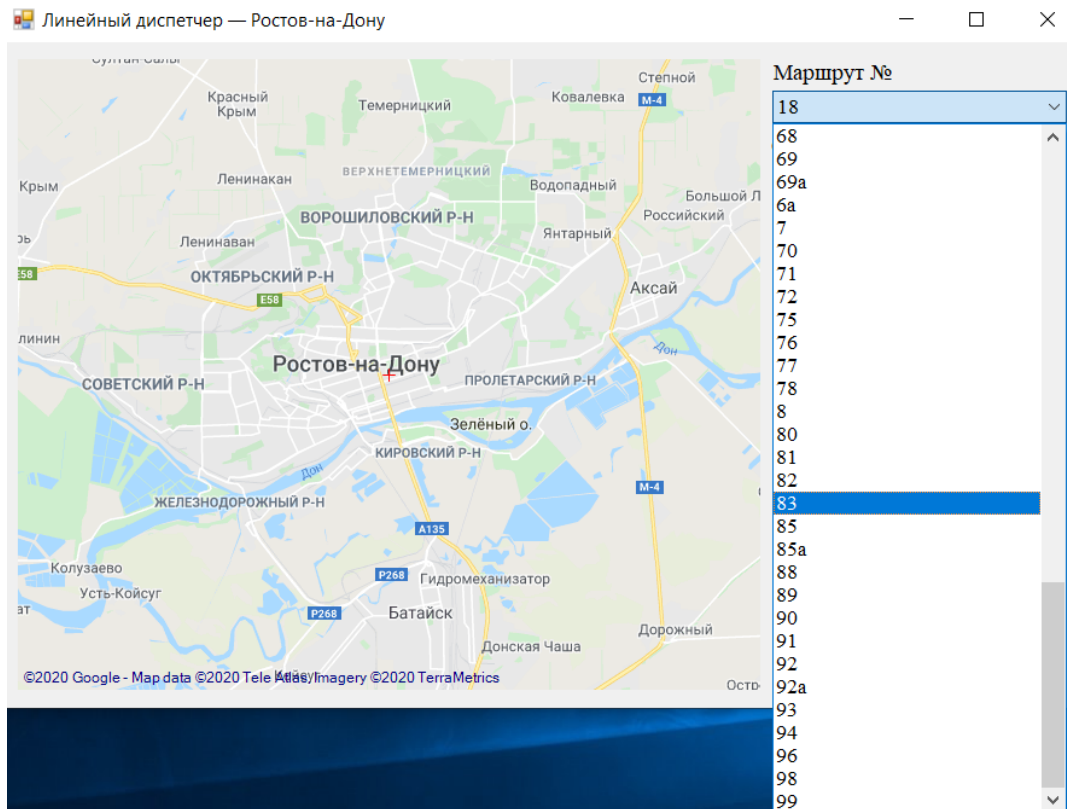
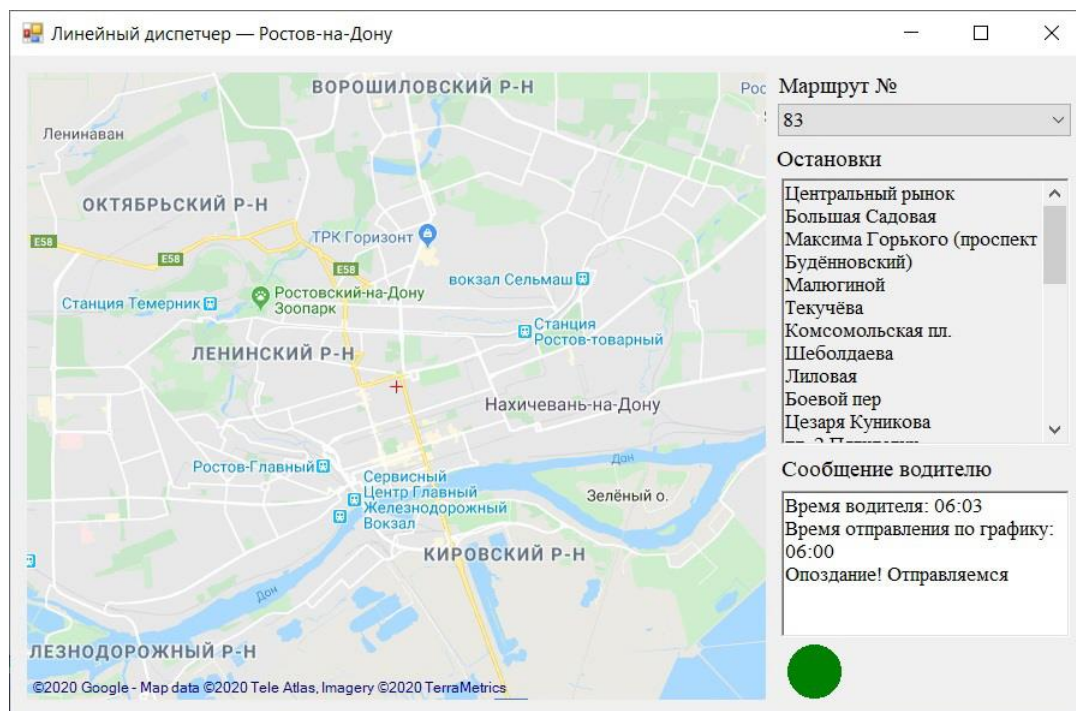Fig. 3. Program menu with a map of the selected city and bus route numbers

Fig. 4. Program window with a map of the city and the stops on the selected route

The "Message to the driver" window displays information about following the schedule. There are two possible situations: moving ahead and lagging behind. The program window in both cases is shown below.

Mobile application for communication between the driver and the dispatcher. To ensure the compliance with the traffic schedule on the route, eliminate downtime at stops and congestion of transport at bus stops, a mobile

application has been developed. The mobile app can be installed on any smartphone of the driver and the dispatcher. After receiving the message about a violation of the traffic schedule, the dispatcher can contact the driver and find out the reasons. The driver can also contact the dispatcher. In addition, in case of a violation of the traffic schedule, messages can be automatically sent to the dispatcher. Before the start, the driver or the dispatcher opens a window with a form to log in. You must fill in all the fields. After filling in the fields, as well as the information about the driver on this route, a list of bus numbers in the city appears. Figure 5-6 show screenshots of the application running on the Android OS.
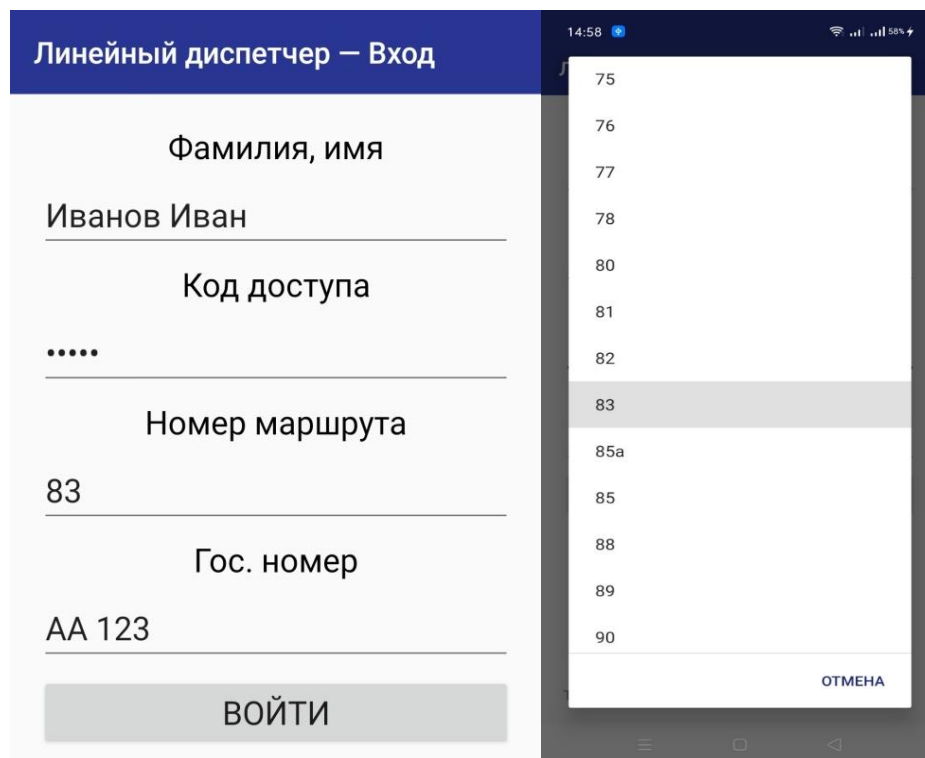

Fig. 5. Mobile app start menu and a list of city buses

Description of the program. The mobile app is written in C# using cross-platform Xamarin.Forms technology, which allows you to run the program on any smartphone. After entering the application, the main window of the program opens, which displays a list of stops and displays a message to the driver about the compliance with the schedule (Fig. 6 a and 6 b) and a map of the city (Fig. 6 c).
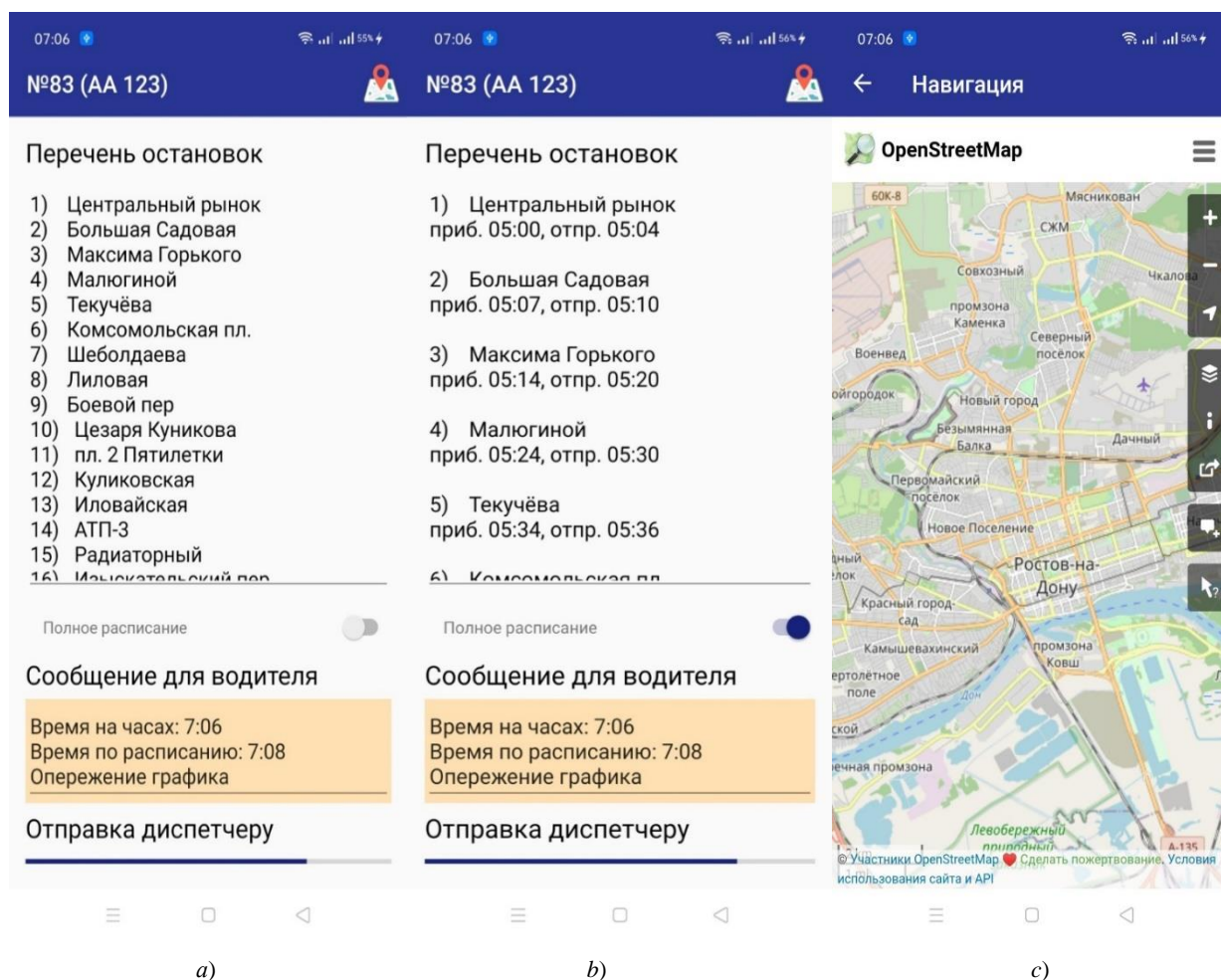
a)   *b)*   *c)*

Fig. 6. Traffic schedule: a — list of stops and a message to the driver and the dispatcher; b — list of stops with the time of arrival at the stop and the time of departure; c — navigation on the map of the mobile application

All messages are sent to the dispatcher. The schedule delay is marked in red, and the lead is yellow, so that the driver can quickly navigate by color.

Conclusion. Modern society needs a constant increase in the volume of transport communication, improving its reliability, safety and quality. This requires the increase in the cost of improving the infrastructure of the transport network, turning it into a flexible, highly managed logistics system. The algorithm is proposed and the Line Dispatcher program is developed. The program allows you to choose any route in Rostov-on-Don, download the data about bus stops and travel time on the route. The program monitors the progress of the driver's schedule and informs him about the violations in the form of a text message and a color signal. A mobile application for the driver and the dispatcher has been developed. The mobile application is written on a cross-platform basis, which allows you to install it on any smartphone. The implementation of this development will help to optimize the movement of public transport and improve the environmental situation.

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Contribution of the authors:

S. I. Popov — formulation of the main concept, correction of the conclusions; G. A. Galchenko — formulation of the main concept, goals and objectives of the study, development of the algorithm, analysis of the research results, revision of the text, correction of the conclusions; Yu. V. Marchenko — field observations, development of the algorithm; D. S. Drozdov — software implementation in C++ of the program "Linear Dispatcher" and the mobile application.